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BUREAU OF MINES
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INFORMATION CIRCULAR

MERCURY POISONING AS A MINING HAZARD

BY

SARA J. DAVENPORT AND D. HARRINGTON

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November 1941.

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

MERCURY POISONING AS A MINING HAZARD[1]

By Sara J. Davenport[2] and D. Harrington[3]

CONTENTS

	Page
Introduction	1
Poisoning in the mining and allied industries	3
Mode of entrance to the body	6
Symptoms	7
General symptoms	7
Individual symptoms	10
Inflammation of the mouth	10
Psychic irritability	11
Tremor	12
Pathological effects	12
Distribution of mercury in the body	12
Pathological changes	15
Toxicity of mercury	16
Hypersensitiveness to mercury	17
Detection of mercury in air	17
Treatment of poisoning	18
Prevention of poisoning	19
Glossary of medical and other technical terms	24
Bibliography	26

INTRODUCTION

With the increased demand for mercury incident to preparations for national defense and the reduction in imports from some of the usual sources owing to war conditions, many small mines in the United States are now being worked that ordinarily would be unprofitable. This is indicated by the following table on mercury produced in the United States in 1939-40 (1)[4]

1/ The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7180."

2/ Principal translator, Bureau of Mines, U. S. Department of the Interior.

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4/ Figures in parentheses refer to references at the end of the circular.

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State	1939			1940		
	Producing mines	Flasks	Value[1]	Producing mines	Flasks	Value[1]
Alaska	-	-	-	1	162	$28,653
Arizona	(2)	(2)	(2)	6	740	130,884
Arkansas	5	364	$37,834	10	1,159	204,992
California	59	11,127	1,156,540	70	18,629	3,294,911
Nevada	25	828	86,062	42	5,924	1,047,778
Oregon	14	4,592	477,293	23	9,043	1,599,436
Utah	-	-	-	1	53	9,374
Other States[3]	4	1,722	178,985	6	2,067	365,590
	107	18,633	1,936,714	159	37,777	6,681,618

1/ Value calculated at average price at New York.
2/ Included under "Other States."
3/ Includes Arizona, Idaho, and Texas in 1939 and Idaho, Texas, and Washington in 1940.

As operating methods at most of these small mines are more or less crude the workers may be exposed to a serious health hazard from poisoning by mercury, especially in mines where there is an admixture of native quicksilver. A similar situation arose during the World War, when, according to Hamilton (2), acute mercurialism became so prevalent at some small mines that they had to be abandoned, although the men worked in 2-hour shifts (with 2 hours off between shifts), had every care (including hot sulfur baths), and were urged not to work too hard. Safety engineers of the Bureau of Mines reported recently that 14 men at a mine in California who worked 4 days relining a rotary kiln developed more or less severe symptoms, particularly diarrhea, hemorrhages of the stomach, vomiting, dizziness, and headache. The job was a rush one, and the men worked in some heat and dust without respiratory protection or ventilation. All recovered except one man, who suffered severe aftereffects. He had worked for the quicksilver-mining company for about 3 years.

At another mercury operation visited by Bureau of Mines engineers, tests with a mercury lamp and a midget impinger (converted to sample mercury or particulate size that would not be registered by the vapor lamp) at a typical retort revealed the presence in the air of the following combined concentrations:

Place and conditions of test	Hg, in mg. per cubic meter	Remarks
Top of large retort, cooking, 4 hours	0.23	Vapors.
At large retort:		
Loading and pulling	.80	Dust.
1 to 2 hours per shift	2.46	Vapors.
Total	3.26	

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It was evident that persons working about these retorts were subject to excessive risks of mercury poisoning, and it was admitted that several men had been affected and had been unable to continue on the job. The man in charge was no longer able to risk working on the pulling or loading of the pipes.

Owing to greatly expanded domestic production (greater in 1940 than in any year since 1883) the hazard of mercury poisoning is greatly increased.

In view of the immediate necessity for conserving the health of the Nation's workers by eliminating as far as possible potential sources of injury thereto, a review of the occurrence of mercury poisoning in the mining and allied industries and methods for its control is believed to be timely.

POISONING IN THE MINING AND ALLIED INDUSTRIES

The element mercury must have been known at a very early time, as a small vessel full of the metal was discovered by an archaeologist in a grave estimated to belong to the sixteenth or fifteenth century B.C. Mellor (3) states that it was known to the Phoenicians and Carthagenians in 700 B.C. Apparently the latter used it, as they are said (4) to have exploited the veins near Almaden, Spain, where they obtained Argentum vivum in greater abundance than in any other region. These mines were exploited by the Arabs, as is indicated by terms of Arabic origin still used by the natives. Aristotle (320 B.C.) referred to the use of mercury by the priest (3), and about the beginning of the Christian era, Dioscorides mentioned it in his De materia medica. In writing of the diseases of slaves Pliny, the Elder (5), mentioned mercurialism. Paracelsus (6) referred to it in his book on miners' diseases published in 1567 and was the first to explain (2) the effects of mercury upon the body.

Mercury is liquid and volatile at ordinary temperature, and volatilization is not arrested by freezing (3). Poisoning may occur in any industry in which mercury is used as a result of handling it or inhaling its vapors or dust. Dublin and Vane (7) list 80 industries as having a potential mercury-poisoning hazard. Its presence in the mining and retorting of mercury, in the manufacture of explosives, and in technical-laboratory work will be discussed in this circular.

The main source of mercury is cinnabar, the sulfide HgS. Mercury poisoning may develop in mining from handling ore that contains free mercury, from dust and fumes that may escape during retorting the ore and condensing the vapors (likewise in the retorting of gold amalgam), and from the handling of liquid mercury. The principal sources of poisoning in reduction plants are at the ore-feed end of the furnace, at the hoeing table, and in the ash pits.

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According to Pollet (8), undoubtedly hydrargyrism, with saturnism, is the most classic and anciently known of the industrial diseases, certain mercury mines having been exploited from Roman antiquity. In connection with these mines, the first labor regulation appeared in Friuli (Italy) in 1665, and in the same year Pope (8) described the mercurial tremor of miners. Mercury and lead were the first industrial poisons to be compensated in France (8).

In an investigation of conditions in the California field in 1923, Hamilton (9) found that the men in the field were familiar with mercurialism, as most of them at some time had suffered from at least one attack of what they called "salivation," although apparently they used the term for any form of mercury poisoning. The most rapid and severe cases occurred in those working on old-type furnaces, in mining native ore, and in working up the dirt under old furnaces or in the ruins of a fire. Recent inquiry by Bureau of Mines safety engineers in California reveals that poisoning occurs in underground mining mostly where free quicksilver is present in the ore and to a less extent in mines with cinnabar as the principal ore.

In 1916 and 1917 mercurial poisoning in Great Britain increased owing to the greatly augmented use of fulminate of mercury in the manufacture of explosives. In the United States this form of poisoning was very troublesome, causing excessive labor turn-over in manufacture of detonators, according to data collected in 1916 before the United States entered the war (9). The normal annual consumption of mercury in the United States ranges from 25,000 to 35,000 flasks of 76 pounds each (10). In 1930, 20 percent was used in the making of fulminate.

Thirty-two cases of acute mercury poisoning in workmen engaged in cutting out the tops of stills that had been closed with mercury seals to prevent the escape of vapors were reported by Williams and Schram (11) in 1937. During the course of operations extending over several years, small quantities of mercury had been spilled from time to time from the open seals upon the lids of the stills. As it is almost impossible to pick up small droplets of mercury, some of it always remained on the lids, and each time the stills were spray-painted these fine droplets of mercury were covered.

At the time of the incident mentioned by Williams and Schram all of the visible metallic mercury had been removed from the seals and cleaned up before the welders began cutting the holes with oxyacetylene torches. The work was done in an air-conditioned room with closed windows.

On the first day the cutting was done there was not enough ventilation, although electric fans were used and the doors to the room were open; on the second day the windows were removed and fans and compressed air were used; on the third day, during which the job was finished, oxygen tanks and masks were used. The men exposed on the first day were affected most severely, three of them requiring hospitalization. These men were the welders, the actual handlers of the oxyacetylene torches; the welders also

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experienced the severest symptoms on the second day but were not hospitalized. The men employed on the job on the third day had not been exposed previously and were unaffected. The laborers and helpers had symptoms of gingivitis, which persisted for various periods up to 2 weeks, but were able to continue work.

Collis (12) has called attention to the special importance of a report of sickness of workers exposed to fulminate of mercury in a cartridge-loading factory in France in 1939. Many persons were affected, but only six cases are given in detail by the observers Joltrain, Hissard, and Boulard (13). Four of the six cases were workers who were exposed to fulminate powder and whose symptoms simulated diseases of sensitization. The other two cases were men exposed to fumes from carboys containing the very toxic fulminic acid composed of colloidal mercury and ethyl nitrite. The toxicologist who investigated these two cases believed that ethyl nitrite was the principal cause of the poisonings.

Whoever works with quicksilver is exposed to the hazard of poisoning. According to Stock (14), in addition to industrial workers, who usually are well-protected by hygienic measures, physicists, chemists, physicians, dentists (work with amalgam), natural-science teachers, and others are possible victims of mercury poisoning. Most experimental scientists have become so accustomed to handling mercury in calibrations, manometers, and pumps that they do not think of it as poison; yet Pascal, Berzelius, Heinrich Herz, and Faraday are said (14) to have suffered severely from mercury poisoning without realizing the source of their symptoms.

In an investigation conducted by the Bureau of Mines (15) to determine the possibility of chronic mercury poisoning in petroleum-research laboratories, the air of two analytical laboratories of the Bureau was tested to determine the concentration of mercury present. It was found that although the use of liquid mercury does not always result in the establishment of a definite health hazard because of mercury vapors, such use does represent a constant potential hazard from poor housekeeping and inadequate year-round ventilation. Test results showed that a concentration of 0.6 milligram of mercury vapor per 10 cubic meters of air (an amount known to have occasioned poisoning) may easily be exceeded in the two petroleum laboratories investigated when natural or inadequate mechanical ventilation is depended on to dissipate the vapors given off from exposed surfaces of liquid mercury.

In a study of mercury vapor in the air of 38 ventilated and unventilated laboratories at the National Bureau of Standards and elsewhere, conducted by that Bureau in cooperation with the United States Public Health Service (16), the following information was obtained regarding quantities of mercury present:

> Of the 61 laboratories tested, 28 yielded less than 4 micrograms of mercury per cubic meter of air, 16 yielded amounts varying from 4 to 12 micrograms, 7 yielded up to 20

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micrograms, and 10 yielded up to 70 micrograms. The amount of mercury vapor found depended primarily upon ventilation and thereafter upon the number and types of local sources and the degree to which mercury surfaces were disturbed by mechanical means or mercury was vaporized by heating. The survey was not sufficiently extensive to justify any statistical correlation between the type of laboratory, in terms of physical or chemical, with the amount of mercury found, even though the largest amounts were found in physical laboratories. If such a correlation exists, it would probably find its natural explanation in the fact that chemical laboratories are generally very well ventilated, and special physical laboratories may not be. The total amount of mercury actually used is not the important factor. This is illustrated by comparing room 209 C, which yielded 8 to 12 micrograms per cubic meter of air, with room 0 C, which yielded 60 micrograms. At least 500 pounds of mercury is regularly used in room 209 C and only a few grams in room 0 C. Although most of the mercury in the former laboratory is kept within closed glass vessels, the surface exposed to air far exceeds that exposed in the latter room, and in addition there are other local sources not present in the latter room. The difference lies in the ventilation.

In general, the survey should be comforting to those who work in well-ventilated laboratories and are not careless with their mercury. It may give a moment's pause to those who are too careless, and should cause some real reflection on the part of those who work with even small amounts of mercury in unventilated rooms. Whether such reflection is entirely justified is a problem for medical agencies.

A medical examination of the workers in these laboratories revealed no evidence of mercurialism in those exposed to concentrations of less than 4 to 70 micrograms of mercury per cubic meter of air. Other studies by the Public Health Service showed that cases of mercurialism occurred only with exposure to concentrations of more than 100 micrograms per cubic meter of air.

MODE OF ENTRANCE TO THE BODY

In industrial mercury poisoning the portals of entry to the body are usually the skin through exposure to the dust as it settles on the body or clothing, the respiratory passages through inhalation of mercury dust or vapor, and the gastrointentinal tract through swallowing with food or other substance taken into the mouth. Stock (14) states that chronic poisoning is produced principally by inhalation of mercury vapors, and that the same quantity of mercury is more dangerous when inhaled than when introduced by mouth into the digestive organs. The mucous membranes of the upper respiratory passages (nose, pharynx, palate) play an important role in poisoning by inhalation. The nasal mucosa in particular

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absorbs the poison rapidly, becoming inflamed and necrotic, and the toxic action is extended through the lymphatic ducts of the olfactory bulb to the meninges (determined by experiments on dogs), which explains the nervous symptoms observed at clinical examination. It is in these organs that the highest content of mercury (five to six times more than in other organs) is found at autopsy (14).

Absorption of mercury metal through the skin is possible. The hazard from handling the metal, however, would be due to contamination of food, smoking materials, or other contact with the mouth by the mercury on the hands rather than by direct absorption of the mercury through the skin. Mercury enters the body by way of the skin chiefly through the sebaceous-gland openings; as the palms of the hands contain no sebaceous glands, little or no mercury will enter, despite sustained massage from work (17). According to observations by Bureau of Mines safety engineers, men working in mercury mines and around reduction plants are careless about keeping their hands and bodies clean while smoking and eating and after their day's work is finished. Smoking underground in mercury mines is a frequent means of contracting poisoning. The superintendent of a mine persuaded some of the men who smoked and were complaining of cramps and nausea to quit smoking for a time; the symptoms disappeared. The man who smokes cigarettes with quicksilver on his hands unconsciously puts his fingers on his mouth, and if he smokes a pipe, cinnabar is likely to get into the bowl of the pipe and be roasted.

Cases of mercury poisoning have been reported among the members of the families of miners in Idria, especially when the children slept in the same bed as their father (18).

SYMPTOMS OF POISONING

General Symptoms

According to Sayers (19) industrial mercury poisoning about mines and reduction works usually is chronic, with occasional development of acute or subacute symptoms when workmen are exposed to large amounts of mercury vapors, dust, or soot. In patients not physically fit, as the tuberculous and alcoholic, Giglioli (20) observed bleeding from the intestines, nausea, colicky pains, and sometimes retching. When the mercuralism was acquired more slowly, as in men of good constitution and careful hygienic habits, the general course of symptoms was as follows: First loss of appetite, stomatitis, and intestinal disturbances were experienced sometimes, but not always; after a period ranging from less than a year to 2 or 3 years or even more tremors developed. The tremors usually began during the night, with convulsive movements, known as "jerks," interrupting the patients' sleep. Hamilton (21), however, states that the tremor disappears in sleep, even in severe cases, and is always lessened by repose and solitude.

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With exposure to large quantities of mercury fumes, dust, or soot, poisoning may be almost subacute (19). The four breath, salivation, and metallic taste in the mouth that appear first may be followed by receding of the gums, which become sore and swollen, loosening of the teeth, and sometimes ulceration of the cheeks and gums. The skin generally becomes yellowish white, similar to that found in some forms of malaria, but this symptom is not constant enough to be called characteristic. Punctiform hemorrhages of the skin of the back and arms are found in many furnace workers but in few miners. These punctiform hemorrhages probably are evidence of the action of mercury on the blood.

According to Hamilton (21) the picture of mercurial poisoning found in textbooks on toxicology is not that usually seen in industrial mercurialism; the severe gastrointestinal symptoms and eruptions on the skin mentioned in the textbooks are rare in industrial poisoning. Cases of this type found in industry are milder and occur only where the exposure is unusually severe. It is interesting to note in this connection that the symptoms of the 14 men reported by Bureau of Mines safety engineers as affected by exposure to mercury were diarrhea, hemorrhages of the stomach, vomiting, dizziness, and headache. One of these men, who suffered aftereffects, experienced the symptoms mentioned by Hamilton as usually present in industrial cases.

Hamilton (21) lists inflammation of the mouth, muscular tremor, and psychic irritability as the three characteristic features of industrial mercurialism. She states (21) that although textbooks on toxicology mention eczema as common, she never saw a case in a miner, furnaceman, or hatter, but that it is the characteristic form of poisoning in fulminate workers. She quotes (21) Oppenheim's interesting theory that in cases in which the skin does not allow the mercury to pass, skin dermatitis results; where the skin allows the mercury to pass there will be no local irritating action but an action on the deeper tissues - systemic mercurialism.

Among the 32 cases reported by Williams and Schram (11) one of the hospitalized victims of poisoning suffered at first from gingivitis, salivation, and headache; later acute abdominal cramps developed, with diarrhea and bloody stools; and later still he complained of severe pain in the mediastinum, which was accompanied by prostration, a temperature of 99°, pulse rate of 100, and respiration of 24. The symptoms of the other two were similar, except there was no blood in their stools.

A condition experienced by their patients that apparently has not been noted in other mercury-poisoning cases is reported by Williams and Schram (11) as follows:

> Another point - frequently noted in people who are ill, in that there are periods when they feel better and then not so well - was very sharply defined by many of these men, especially among the more toxic, and special notation was made regarding it in caring for the hospitalized patients.

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Within 15 minutes there would be an abrupt and marked change in the patient's condition, and there were numerous recurrences of these changes. A patient would be seen sitting up in bed, with no objective or subjective symptoms, and stating that he was feeling fine. In a very few minutes there might be prostration, cold sweat, difficult breathing, mediastinal pain, and abdominal cramps. These symptoms would disappear as quickly as they arose, only to recur in from one-half hour to several hours. There was no regularity about the time element in the buoyant or low periods.

The symptoms developed by the men working in 1939 in a French cartridge-loading factory (13) were paroxysmal hemoglobinuria, spasmodic coryza, Quincke's edema, and eczema affecting especially the face and upper extremities. It was decided that these symptoms were of anaphylactic order (exaggerated reaction of the organism to a foreign substance). The following detailed report of one of these cases may be of interest:

Observation 1.--B...(Robert), 36 years old, was mobilized at the cartridge factory on September 2. On the 12th he was assigned to weighing and distributing fulminate powder. From the first contact he was inconvenienced by repeated sneezing and abundant rhinorrhea (free discharge of a thin nasal mucus). The second day his eyes watered and he soon experienced a smarting sensation in the eyelids. At the end of a week, during which his condition had remained stationary, he observed some itching and pruriginous spots of erythema on the anus and chest, which disappeared two days later. On the 27th the patient discovered some "pimples" on his face, upper lip, and chin. He was hospitalized. We saw him on the 30th. He presented then at the commisures (points of contact) of the lips lesions that resembled perleche (a contagious microbic disease of the lips) and small scabs in the beard and moustache. The rest of the face was unaffected, except that the eyelids were a little red and the lower half of the left ocular conjunctiva was injected as well as the mucosa of the eyelids.

This man had never been ill and had never been affected by cutaneous lesions.

Holstein (22) also has called attention to the effect of mercury, especially compounds of mercury, on the skin. Eczema and severe inflammation of the skin may be present, especially in acute poisoning. He states that in exposure to organic mercury compounds symptoms of poisoning by the more quickly acting secondary ingredient may appear before those of the more slowly acting mercury.

In a study of 17 apparently healthy workers in a German hat factory, Tallenberg (23) found the following general physical conditions present: Only one of the five men examined was well-nourished, the other four were

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thin, with a very slight cushion of fat and a flaccid musculature. Two of the wormen were decidedly fat, three were normal, and seven (58 percent) had a slight cushion of fat and a flaccid musculature. Moodiness, embarrassment, irritability (especially at work but also at home), and violent anger were observed in the 17 workers.

The women volunteered the information that children born before their parents (especially their mothers) were employed in the hat factory came into the world stronger and grew up healthier than those born afterward.

Stock (14) distinguishes three stages in the symptoms of chronic mercury poisoning, although these stages are not sharply differentiated. In the first stage, almost all symptoms are of a nervous-mental type - exhaustion, decreased mental ability and loss of desire for the work, slight nervousness (irritability), and slight, often overlooked swelling of the mucosa of the upper part of the nose. In the second stage there are increased fatigue, diminished ability to improve, to remember, and to think (feeling of "stupidity"), and a bad memory, especially for figures, names, and persons; internal unrest, irritability, discontent, feeling of pressure in the head and headache between the eyes, numbness, and slight dizziness; increased swelling of the mucous membrane of the nose ("stopped-up" and "dry" nose), nasal catarrh with viscous, slightly bloody mucus, buzzing in the ears, and slight inflammation of the throat; inflammation of the mucous membrance of the mouth and gums (soreness around the teeth), slight bleeding when teeth are cleaned; disturbances of the heart, diarrhea in some cases, slight tremor, and increased pressure to urinate. In the third stage the symptoms are grievous headache, dizziness, slight disturbance of vision, greatly decreased mental ability for work, and inability to speak or write correctly; almost complete loss of memory (feeling of beginning to "lose mind"); deep dejection, and shyness; continual purulent, often bloody nasal catarrh with scab formation, and inflammation of throat and tonsils; loss of sense of smell, difficulty in hearing, and whistling in the ears; blisters and small ulcers on the palate, mouth cavity, and lips; bleeding of gums at slight touch, tooth pockets and paradentosis (loosening of the teeth), and salivation; more severe diarrhea, frequent desire to urinate with small amount of urine, pain in the region of the loins, heart pressure, heavier sleep of slight healing value, and severer tremor.

Individual Symptoms

The three characteristic features of industrial mercurialism - stomatitis (inflammation of the mouth), psychic irritability, and muscular tremor - are discussed in detail below.

Inflammation of the mouth

Sayers (19) mentions two forms of stomatitis - subacute and chronic. The subacute type occurs in those who have worked around mercury for a short time. The mucous membrane of the cheeks and gums is swollen and redder than normal, and some cases show ulcers on the cheeks and gums.

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However, cases of ulcerative stomatitis were not found by the United States Public Health Service (24) in its study of chronic mercury poisoning in the hatters' fur-cutting industry. The chronic form appears in those who have worked around mercury for a number of years. In this type the gums recede from the teeth, exposing the roots. The teeth may become loosened and, in severe cases, lose their enamel and appear wrinkled and broken. At a later stage they fall out - especially the lower teeth - as a consequence of a process of expulsive gingivitis often accompanied by abscesses (18). The buccal lesions heal as soon as no more teeth remain, or at least around teeth that have fallen out. A dark line was found by the Public Health Service (24) investigators on the gums of six men and one woman who had fine intention tremors. This line appeared as a narrow, irregular row of closely-set, bluish-black dots running roughly parallel to the gingival margins.

Among the workers examined by Tallenberg (23) only one (a woman who had been employed in the felt hat industry only 2 years) had sound teeth. He mentions that the falling out of the teeth is not always painful. In addition to caries, a bluish-black or greenish-black coloring was observed on the teeth (especially the incisors) of four of the men. This was not found on the teeth of the women.

Sometimes the stomatitis takes the form of a purulent gingivitis (18) with fetid discharge (alveolar dental pyorrhea). The tonsils and pharynx also sometimes are inflamed (mercurial pharyngitis of Kussmaul). As an ultimate, though rare, effect of stomatitis, necrosis of the maxillary bones is said to occur. The stomatitis is accompanied by objective symptoms (pains, headache) or functional symptoms (anorexia, fatigue).

In a study of mercurialism among fur cutters, the United States Public Health Service (24) found gingivitis (including pyorrhea and gum inflammation in which pus exudation was not demonstrable) somewhat more prevalent in persons with chronic mercurialism than in those not so diagnosed. However, the incidence of gingivitis had no direct relationship to the degree of mercury exposure and was no greater in groups with a high mercury-vapor exposure than it was for groups with a low mercury-vapor exposure who were employed for the same length of time.

Among 100 Danbury hatters examined in 1922 by Wade Wright (21), only 22 gave a history of salivation and 25 of abnormal dryness of throat and tongue; 45 had gingivitis and pyorrhea.

Psychic irritability

According to Holstein (22) the most important effect of industrial mercury poisoning is on the nervous system. The nervous symptoms may appear in chronic poisoning without signs of disease in the mouth or throat. He refers to the change in personality as outstanding among the manifold symptoms of mercurialism. In its severest manifestation it is characterized by heightened excitability, the medical term for which is erethism; this is a peculiar mixture of frightened embarrassment, perplexity, uncertainty, and dread. Ordinarily the sufferer can scarcely be

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distinguished from other, healthy workers except by a certain haste in his movements. However, when he feels that he is being observed the picture changes. Every trifle, an unexpected meeting, causes agitation and embarrassment. Blushes alternate with pallor; he is unable to continue work begun, to write or work with his hands, or to complete a sentence. An uncontrollable state of excitement can be aroused by a slight happening and result in actions of violent anger. He cannot bear contradiction or criticism. During conversation he may suddenly burst into tears. The inability to repress this expression of feeling may excite him still more. Formerly peaceable men become insufferable in the community and an affliction to their families. There may be other psychic manifestations, such as mental changes. Some victims of poisoning are absent-minded and others are slow in thinking and sometimes the thoughts are singular or childish. Loss of memory, especially for figures and counting, is sometimes so great that the victim of poisoning cannot play his accustomed card games.

Tremor

Holstein (22) states that tremor usually appears as a sequel to the erethism and the psychoneurotic symptoms; on the other hand, these morbid changes seldom appear without premonitory symptoms. Tremor usually begins bilaterally in the fingers, then spreads to the hands and lower and upper arms. The lower extremities may be affected in the same manner; this is apparent first in unsteadiness in standing and walking or in trembling of the knees when standing upright. The head may roll about and the trunk make jerky movements. The facial musculature may move in unison with the other affected parts; the eyelids and nostrils may quiver, the outstretched tongue tremble, and the lower jaw move up and down.

The tremor is decidedly intentional, the slightest effort or emotion accentuating it. The victim of poisoning cannot drink from an open vessel or hold smoking materials in his mouth, and often he cannot dress or undress without help.

Pronounced paralysis, for example, of the limbs, has not been determined in mercury poisoning; there is, however, loss of feeling.

PATHOLOGICAL EFFECTS

Distribution of Mercury in the Body

Stock (14) experimented with animals to determine the distribution of mercury after its entrance into the body through the respiratory system by inhalation of the vapor and through the digestive system with food.

In the first series of Stock's experiments with inhalation of vapor, the animals were kept in an atmosphere of 6 to 7 mg. of mercury in 1,000 cc. of air for 1/2 to 4 days and then killed. The lungs, kidneys, and the entire residue (including the contents of the intestines) were analyzed. At first the mercury content of the lungs increased quickly, but more slowly after 2 days; that is, the lungs conveyed to the circulation about as much

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mercury as they received from the air. In spite of the small size of the kidneys, their mercury content increased faster, continued to increase to the end of the tests, and was greater than that of the lungs. The rest of the body remained poor in mercury content; even after 4 days the entire amount was only twice that in the kidneys, which absorbed completely and with surprising speed the mercury passing from the lungs into the circulation, with consequent disturbance of their function.

In the second series of experiments the animals were allowed to remain in the air containing mercury for 10 hours and were then kept in pure air 2 to 60 days before analyses were made. The mercury content in the lungs and rest of the body decreased very rapidly, while that in the kidneys decreased extremely slowly. After 3 weeks, the kidneys contained six times as much mercury as the rest of the body.

In the third series of experiments mercury was administered with the food. The mercury content of the kidneys increased continually, while that of the rest of the body was scarcely changed after 2 days, and after 14 days it was only one-fifth that of the kidneys. An insignificant amount of mercury was found in the liver.

Stock (14) states that mercury is combined chemically and oxidized in the organs and is found in metallic form only after treatment of the kidneys with a reducing agent.

An indication of the greater toxicity of mercury when inhaled than when absorbed by mouth is the fact that after the longest feeding experiments the test animals were lively and enjoyed their food, while in the inhalation experiments their well-being was greatly disturbed, although the mercury content of the kidneys was the same.

Urine analysis (14) reveals that mercury is retained for a long time in human as well as in animal kidneys, and that the function of the kidneys is disturbed by it as much in one as in the other. Inflammation of the kidneys, anuria, and uremia are typical symptoms of mercurialism.

According to Stock (14), the role of the nose in mercury poisoning has not been emphasized enough. The action of mercury in the nose is immediate, as it is absorbed by the mucous membrane and the metallic vapor is oxidized and dissolved. The nasal symptoms are most closely connected with the nervous-psychic symptoms. Animal experiments show that considerable mercury is absorbed in the nose. Examination of rabbits exposed for 4 weeks to low concentrations of mercury in air revealed a content of 6.5 mg. of mercury in the nose and 6.1 mg. in the upper part of the throat, while the kidneys contained 19 and 33 mg.

The mucous membrane of the upper respiratory passage absorbs mercury, and the irritation is especially severe. This explains why the nasal mucosa swells, becomes inflamed and necrotic, sloughs off, and is more susceptible to infection. Mercury is absorbed also in the throat, palate,

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and larynx, which extend the nasal disturbances and, through catarrh of the tubes, lead to buzzing in the ears, deafness, and dizziness and finally cause the symptoms of disease of the mouth and gums.

In referring to the difference between the toxic action of mercury fumes and that of metallic mercury and mercury salts mentioned by Kussmaul, Scopoli, Biondi, Merget, and other scientists, Gelman and Derviz (25) state that the lengthy action of small concentrations of mercury fumes produces a specific form of chronic nervous mercurialism with specific symptomatology (tremor, erethism, encephalopathy) and the complete absence of, or only minor injury to, the excretory organs. In contrast to this, poisoning with metallic mercury and mercuric salts does not cause nervous mercurialism, but does cause injury to the excretory organs (salivary glands, mucus of the mouth, intestines, and kidneys) and is not accompanied by specific injury to the nervous system.

According to Gelman and Derviz (25), the differences in the fates of mercury fumes and compounds in the organism are proved not only by the differences in clinical pictures but also by the differences in the distribution of mercury in the organs and tissues. They found by a study of the organs of animals poisoned by mercury that there was a greater tendency of mercury to concentrate in the brain when the animals were poisoned by the fumes than when they were poisoned by mercuric salts. This qualitative difference is shown more clearly by observations made by the authors in a thermometer factory. Following is a discussion of the results of these observations:

> We investigated a thermometer factory where the content of mercury in the air varies from 0.11-0.43 mgm. per cu. m. We calculated the minimum, average, and maximum amounts of mercury that the workers inhaled in the course of a 6-hour working day, a month, and 10 months.
>
> Typical chronic mercury intoxication was observed in workers in all departments, even those with a minimal amount of mercury fumes in the air. If we were to compare the amount of mercury injected in syphilis cures with the amount of mercury found here we should be greatly surprised at the inconsistency between the amount of mercury entering the organism in either case and the toxic effects. In this curative treatment, 1 cc. of a 1-percent solution of bichloride of mercury is subcutaneously injected over a period of 30-40 days. This means that 290-370 mgm. of metallic mercury are injected during this treatment. Therefore, in 1 month more mercury is injected than enters the organism over a period of 10 months in the most harmful department of the thermometer industry. However, we have never found mention of mercury intoxication with specific nervous symptoms caused by this curative process, either in the literature or in our experience. We frequently observed gingivitis, stomatitis, saliva secretion, irritation of the kidneys, etc., but never a typical mercury tremor, erethism, or encephalopathy.

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Gelman and Derviz (25) explain the difference in toxic action between the fumes and the salts as due to the different physical-chemical states of mercury in either case and their different fates in the organism. Mercury fumes are preserved for a time in the blood in atomic dispersion, which gives them a great surface of action and causes them to penetrate into the tissues and cells more easily, while the salts enter into combination with albumin, blood salts, and tissues to form more or less enormous complex albuminates.

Pathological Changes

The nasal disturbances are spread by the lymphatic vessels of the olfactory bulb to the meninges of the head and brain. According to Stock (14), whoever has observed subjectively the action of mercury vapor on himself knows that the "nervous" difficulties proceed from the nose, at first as locally limited (between the eyes), as a peculiar internal restlessness with a "crawling" feeling, and then as a dull pressure where later more extensive pains in the head appear. Along with these disturbances go the psychic effects, the inability to work, the dejection, and similar symptoms. It is known that the frontal region of the brain is related to the higher psychic functions. The symptoms accompanying mercury poisoning may well proceed from the brain, which is the seat of many hormonal functions.

According to Kulkow (quoted by Stock, reference 14), when indications of changes in the peripheral nerves are present the principal cause is to be sought in the central nervous system; there is diffuse injury to the brain through mercury poisoning (toxic cerebropathy), localized principally in the cerebellum. The intention tremor is explained by injury to the cerebellum from chronic inflammation of the central nervous system owing to mercury poisoning. Stock (14) claims that mercury passes in a chemically bound, soluble form through the olfactory bulb into the neighboring parts of the brain and irritates them as it does the mucosa of the nose. To prove this, Stock inhaled mercury vapor through the mouth, closing the nostrils to keep the vapor from entering the nose. He suffered no psychic symptoms, although he inhaled 10 times the volume of air that caused such symptoms when inhaled through the nose.

Vannotti (26) summarized the effects of mercury poisoning as follows:

1. Toxic and in part inflammatory irritation of the tissues follows direct action of the metal on the organism with a picture of a mercury complex with the body's own substances. The direct participation of the protein in this complex explains the long, symptomless period of sensitization of the organism and the shocklike reaction taking place afterward with reintoxication. To the picture of this protein reaction belong the extensive necroses of the membranes, the disturbances of the stomach and intestines, the hypochloremia (lowering of the chloride content of the blood), the diarrhea and vomiting (a result of the loss of chloride, especially the transmineralization of the chloride in the tissues, not recognized by many authors), and other symptoms due to protein destruction.

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2. Injury to individual organs as a result of local action of the poison on certain tissues is seen in the effect on the nervous system (peripheral and central), the kidneys, and the liver.

3. Disturbances of the normal relations and correlations between the affected organs and between an organ and its surrounding are observed. This is a question of a series of secondary processes that do not belong to the direct action of the poison but correspond to altered metabolism. Among the typical signs of this condition are the abnormal relations between liver and kidneys and secondary symptoms such as disturbances of the neurohormonal system.

Tallenberg (23) found definite injury to the functional elements of the liver in a large percentage of apparently healthy mercury workers examined by him. He determined this by the Takata reaction and galactose precipitation tests. He states that the functional disturbance of the liver apparently belongs to the early symptoms of chronic mercury poisoning and believes that a connection between disease of the liver and of the nervous system in mercury poisoning cannot be excluded.

TOXICITY OF MERCURY

The concentration of mercury vapor in air that would cause poisoning was determined experimentally only comparatively recently, previous figures having been largely guesswork and, according to Stock (14), incorrect. In 1934 Fraser, Melville, and Stehle (27) published the results of their experiments to determine the minimum toxic or injurious concentration of mercury vapor in air. They were the first to determine the proportion of inhaled mercury expelled in the expired air and to calculate from the data obtained the quantity retained in the body. They found that a concentration of 1.89 mg. of mercury vapor in a cubic meter of air inhaled 8 hours daily for 40 days did not produce ostensible evidence of mercury poisoning. The minimal concentration of vapor that invariably led to chronic toxic effects under similar conditions of exposure was 3.05 mg. of mercury in a cubic meter of air.

Stock (14) states that working for years in a room containing 3 mg. of mercury vapor in 1 cubic meter of air will cause no difficulties worth mentioning if there is no hypersensitive person among the workers. Longer exposure (for example, working longer hours for several weeks in rooms containing 10 to 20 mg. in a cubic meter of air) causes definite nervous and physical symptoms of poisoning. Higher concentrations, such as were present in ancient laboratories, act correspondingly faster.

From the data obtained in its study of mercurialism in the hatters' fur-cutting industry, the United States Public Health Service (24) found it impossible to define a reasonably safe maximum concentration of mercury in workroom atmospheres. Symptoms of chronic mercurialism developed among individuals working in atmospheric concentrations ranging from 0.6 to 7.2 mg. per 10 cubic meters. The severity of chronic mercurialism and the percentage of persons affected increased with the degree of exposure to mer-

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cury. The incidence of chronic mercurialism increases rapidly with increasing mercury concentration after the concentration exceeds 2.0 mg. per 10 cubic meters. For instance, of the 377 persons exposed to 2.0 mg. or less per 10 cubic meters at the time of the study, 4.5 percent were diagnosed as having chronic mercurialism; and of the 152 persons exposed to greater mercury concentrations, 17.1 percent were so diagnosed.

Hypersensitivity to Mercury

Apparently exposure of some persons to mercury vapor renders them more susceptible to poisoning if exposed again even to low concentrations that originally would not have caused symptoms. A possible example of this is the severe aftereffects suffered by one of the 14 men reported by Bureau of Mines engineers as poisoned by mercury while relining a rotary kiln. The occupation of the man in question was that of bricklayer, and he had worked 3 years for the quicksilver-mining company, which would be his exposure to mercury. All the men were more or less affected but all recovered except the one who had been exposed to mercury previously. He developed weakness, prostration, and loss of nervous and muscular coordination; his mouth was copper-colored, and jaws and mouth were sore. As he had false teeth the usual effect on the teeth was not apparent. He lost weight and had the usual nervous symptoms of irritability, depression and melancholy, avoidance of social contact, fine tremor of the extended tongue, and loss of strength of hand and fingers, which produced tremulous, illegible writing, even in signing his name, and became more marked when his attention was fixed in an attempt to reduce the effect.

In citing his personal experience with hypersensitivity to mercury, Stock (14) states that 10 years after cessation of his severe poisoning by the metal, exposure to as little as several tenths of a mg. to 1 mg. in a cubic meter of air in his laboratory caused chronic symptoms, which abated when he was away for sometime but always reappeared when he returned to work. He at first thought that his nervous system had been affected permanently, but after thorough investigation decided that he was poisoned anew by reexposure to mercury vapor, his susceptibility from previous poisoning being so great that only 0.1 mg. in a cubic meter of air was required to cause recurrence of severe symptoms. The observation by Gelman and Derviz (25) in a thermometer factory and in connection with the injection of metallic mercury in medical treatment may indicate an explanation of the personal susceptibility mentioned by Stock (14).

DETECTION OF MERCURY IN AIR

Many methods for the detection of mercury in air are described in the literature. However, the Bureau of Mines (15) and the Public Health Service (24) have found the General Electric selenium sulfide detector preferable because of its portability, ruggedness, and simplicity of operation and because direct readings may be obtained in a short time. The principle of detection utilized by this instrument is the change in color of the light-yellow selenium-sulfide-coated test paper to varying shades

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of slate-brown. The color change is due to the reaction of metallic-mercury vapor with the selenium sulfide. The degree of color change or darkening depends on the concentration of mercury vapor in the atmosphere under test, the velocity of the air passing over the sensitized surface, the temperature of the air being tested, and the length of exposure. A calibrated chart is provided by which the concentration of mercury vapor in the atmosphere under test may be determined by matching the color of the exposed test paper with the nearest resembling shade on the chart. These chart readings are given in parts of mercury vapor per 100,000,000 parts of air by volume. The manufacturer claims possible readings as low as one part per 100,000,000 when the detector is operating under specified conditions, which requires the use of a 25-watt red Mazda lamp and the atmospheric temperature kept within the range of 20° to 40° C. (68° to 104° F.).

TREATMENT OF POISONING

According to Holstein (22) the symptoms of mercury poisoning usually disappear gradually and in most cases completely after cessation of exposure, and convulsions are fatal only in the worst cases. The first step in treatment of chronic poisoning is to remove the patient from all contact with mercury. If possible he should be kept free of any conditions that may disturb or excite him. He should remain in the open air as much as possible. At first he should rest, then take regular exercise and do work, such as gardening, to stimulate perspiration and hasten elimination of mercury from the body. All attempts to speed the elimination of mercury by medical means have failed. Hot baths are recommended (20) but without addition of other substances such as sulfur.

Sayers (19) has summarized methods of treatment as follows:

> To treat successfully industrial mercurial poisoning, it is imperative that the patient be removed from all possibility of further exposure to mercury. The basis of the active treatment is elimination by stimulating the activity of the kidneys, the intestines, and the sweat glands. Magnesium citrate is a satisfactory cathartic in these cases. Large amounts of water should be taken for their effect on both the kidneys and intestines. Hot baths, sweat baths, and other hydrotherapeutic measures also are beneficial. Iodides usually are prescribed but, according to Schereschewsky (personal communication), are of doubtful value. The stomatitis and digestive disturbances should be treated according to the symptoms. Potassium chlorate solution and astringent mouth washes should be used. Massage is said to be of value in treating the tremors.
>
> The general physical condition of the patient should be improved by an abundant diet of milk, eggs, cream, and other nutritious foods.

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PREVENTION OF POISONING

The first step in the prevention of mercury poisoning is to eliminate the source as much as possible. This can be done by preventing exposure of mercury to the air, as vaporization takes place rapidly at ordinary temperatures and to some extent at temperatures of solidification. Hertz (18) calculated the volatilization of mercury per cubic meter of air as follows:

Temperature, °C.....	0°	10°	20°	30°	40°
Mercury, mg.....2.2		5.7	14.3	31	78

Kunkel (16) found, on the contrary, at the same temperatures:

Mercury, mg.....4.2	6.8	10.4	-	-

According to the experiments of Renk (16), the quantity of mercury per cubic meter of air at a temperature of 10° C. over a surface of 0.5 square meter of mercury was:

1.86 mg. at 5 cm. above the surface
1.26 mg. at 50 cm. above the surface
0.85 mg. at 1 m. above the surface

Mercury vapor is heavier than air, but it does not localize itself in the lower part of a closed space (the laws of gaseous mixtures differ from the laws of liquid mixtures). Vapor produced at a high temperature has a tendency to rise.

Giese (28) found that 1 cubic meter of air saturated with mercury vapor at 25° C. contains 19.5 mg. of mercury and that when a stream of air at 25° C. passes over a surface of mercury 10 cubic meters square at the rate of 1 liter per minute it becomes about 15 percent saturated and will contain about 3 mg. of mercury per cubic meter.

The figures given above indicate the toxic hazard that may be present when mercury is handled carelessly. Droplets of mercury scattered on the floor of the working place may vaporize into toxic amounts in a short time; therefore, every care should be taken to prevent spilling of mercury and to clean it up after it has been spilled. This is a matter of good housekeeping and general sanitation. Floors, benches, and other objects on which dust or droplets may accumulate should be cleaned and swept daily, with a complete general cleaning weekly. Floors should be made of cement or asphalt and should be free of cracks so that the mercury droplets can be removed easily and completely. Good ventilation (preferably mechanical) is necessary to remove the dust and vapor that inevitably contain some mercury wherever the metal or its compounds or ore is used or handled.

In mining the most important measure is thorough ventilation to remove the dust and fumes and cool the air. Keeping the air of working

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places cool will retard to some extent the volatilization of the metal and thus reduce the possibility of poisoning. In hot mines the more or less harmless sulfide ore may be decomposed and enough mercury metal volatilized to cause poisoning. Mechanical crushers and the use of modern airtight furnaces, condensers, and retorts with enough negative pressure to prevent the escape of dust and fumes will prevent poisoning in the various processes of preparing and purifying the metal. However, perfect technique is required to prevent poisoning entirely. Care must be taken in ventilating factories and workshops that mercury-laden air does not contaminate the surrounding atmosphere and injure persons and animals in the neighborhood.

The following are some of the measures recommended by the Industrial Accident Commission of California (29) for the prevention of poisoning in the mining and recovery of mercury:

> Many mercury mines are very warm and enough air should be provided to create in the ventilating current a velocity that will have the required cooling effect. Another function of the ventilating air current is to remove dangerous gases or to dilute them to harmless proportions. It is therefore good practice to supplement the exhaust system with blowers placed with a view to augmenting the movement of fresh air toward the working faces.
>
> In retort reduction plants, the principal hazards occur at the charging and discharging ends of the retorts and also the discharge ends of the condensers. In plants using the rotary type of furnace, the points of exposure are to be found at the feed chute and at the seal rings.
>
> Fortunately, protection against the hazards of retorts and rotary furnaces is not difficult. Respiratory protection in the form of air-line respirators and canister gas masks will protect operators of retorts, but such equipment should not be made to serve continuously instead of removing the conditions which cause the hazard. Leaking seal rings and feed chutes can be corrected by increasing the fan suction to insure in-draft at all joints and openings. If there is some loss of mercury, the cure is not in reducing the suction but in obtaining additional condensing capacity.
>
> Hoeing tables are bad offenders from the standpoint of health hazard. Some attempts have been made to equip such tables with exhaust ventilation. Most of them are not efficient because of poorly designed hoods, inadequate fan capacity, and failure to take advantage of the fact that mercury vapor, being nearly seven times heavier than air, tends to drop—not to rise. Hoods would serve better if designed to pull the vapors to lateral ducts rather than attempt to draw them to a duct in the top of the hood.

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Hoeing tables have been replaced, in some plants, by mechanical hoers. This lessens the danger of poisoning by reducing the period of exposure. In cleaning and washing down condensers, the operator should wear respiratory protection and rubber gloves and in all operations, both in the mines and in the plants, men should be particular in the matter of personal cleanliness, especially before eating. Smokers, and especially those who "roll their own" cigarettes, are in danger from inhaling contaminated tobacco smoke.

The precautions that will reduce the number and severity of cases of mercury poisoning have been summarized by Sayers (19) as follows:

1. The working places should be ventilated, preferably by mechanical means, so that there is always an abundant supply of fresh air.

2. Exhaust ventilation for the shaft furnaces, condensers, and retorts should maintain sufficient negative pressure within them to prevent the escape of fumes and dust at all times.

3. The workers should be supplied with respirators, which should be worn whenever it is necessary to be in mercury dust or fumes.

4. Change and bath houses, equipped with showers (one for every 10 employees), wash basins or taps (one for every 5 employees), and an individual locker for each employee should be provided. Each locker should be arranged in two compartments, one for ordinary clothing and the other for street clothing.

5. Lunch rooms should be located convenient to working places and the depositing or eating of food should not be permitted except in the lunch room.

6. Physical examination should be made of all applicants for employment, and those addicted to drunkenness, those having tuberculosis, those in poor physical condition, and those under 18 years of age should not be permitted to work where they will be exposed to mercury in any way.

7. Physical examination of all employees should be made at least once every 6 months and before returning to work after any illness, and those suffering from mercurialism or those in poor physical condition should be removed from work exposing them to the poisoning.

8. Every employee should be told of the dangers of mercury poisoning and instructed how best to avoid them. This should be done by a responsible person, especially designated for the purpose by the general manager. The employee should be further

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instructed how to avoid the dangers by the foreman of the work to which he is assigned.

9. As personal cleanliness and personal hygiene are important factors in preventing mercury poisoning, the following instructions should be impressed upon each workman:

a. Wash your hands carefully before eating or handling anything that will be placed in the mouth.

b. Always rinse your mouth before taking a drink or eating.

c. Drink water and milk plentifully.

d. Never go to work without having eaten a substantial meal. With an empty stomach, conditions are more favorable for the absorption of mercury into the body.

e. Take a hot shower bath, using soap, at the end of each day's work.

f. Change your ordinary clothing for work before going to work, and your work clothing for ordinary clothing at the end of work. Work clothing should cover the body well, be tight fitting at the ankles, wrists, and neck. A close fitting cap or hat should be worn. The work clothing should be washed frequently, at least once a week.

g. When passing to the leeward of fumes, hold your breath as much as possible. Pass to the windward wherever possible. When necessary to be in fumes or dust, wear a respirator at all times.

h. After having been in fumes, dust, or soot, wash the exposed parts of the body, hands, and face, and rinse the mouth well at the first opportunity.

i. Do not allow yourself to become constipated. Regular habit in this regard is much more important than cathartics. Train yourself to be regular.

j. Care of the teeth and gums is most important. They should be kept clean and healthy. They should be examined at least once every 6 months by a dentist and his recommendations followed.

k. If you feel at all sick, consult the doctor at once.

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A new method of preventing mercury poisoning has recently been tried by the management of a mine in California which was about to be closed on account of the large number of cases of salivation and high turnover (450 percent a month) of employees. A spray solution used in agriculture is said to settle the mercury vapor and form a coating on the metal that renders it inert. The results so far are encouraging, no signs of mercury poisoning having developed in this mine during the 3 months the spray has been in use.

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GLOSSARY OF MEDICAL AND OTHER TECHNICAL TERMS

ALVEOLAR. Pertaining to a tooth socket.
AMALGAM. An alloy of mercury with another metal or metals.
ANOREXIA. Loss of appetite for food.
ANURIA. Suppression of secretion of urine.
ARCHAEOLOGIST. A specialist in the science of prehistoric man.
ARGENTUM VIVUM. Live silver.

BILATERALLY. On both sides
BUCCAL. Pertaining to the cheek.

CARIES. Decay of the enamel and dentin of the teeth.
CEREBELLUM. That division of the brain concerned in the coordination of movements.
CEREBROPATHY. Any disorder of the brain, especially one due to overwork.
COMPLEX. An intricate combination of contributing factors.
CORYZA. Cold in the head.

EDEMA. The presence of abnormally large amounts of fluid in the intercellular tissue spaces of the body.
ENCEPHALOPATHY. A degenerative disease of the brain.
ERETHISM. Excessive irritability.

FLACCID. Weak, lax, soft.

GALACTOSE. A white crystalline sugar.
GASTROINTESTINAL. Pertaining to the stomach and intestines.
GINGIVAL. Pertaining to the gums.
GINGIVITIS. Inflammation of the gums.

HEMOGLOBIN. The oxygen-carrying red coloring matter of the red blood corpuscles.
HEMOGLOBINURIA. The presence of hemoglobin in the urine due to destruction of the blood corpuscles in the vessels.
HEMORRHAGE. Bleeding.
HORMONAL. Pertaining to or of the nature of hormones. A hormone is a chemical substance produced in an organ which, when carried by the blood to an associated organ, excites functional activity in the latter.
HYDRARGYRISM. Mercury poisoning.
HYPOCHLOREMIA. Lowering of the chloride content of the blood.

MEDIASTINUM. The space in the chest between the pleural sacs of the lungs.
MENINGES. The three membranes that envelop the brain.
MERCURIALISM. Chronic mercury poisoning.
METABOLISM. The sum of all physical and chemical processes by which living organized substance is produced and maintained, and also the transformation by which energy is made available for the uses of the organism.
MUCOSA. The mucous membrane.

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MUSCULATURE. The muscular apparatus of the body, or any part of it.

NECROTIC. Affected by death of a circumscribed portion of tissue.
NEUROHORMONAL. Pertaining to the nerves and the hormones. (See definition of hormonal).

OLFACTORY. Pertaining to the sense of smell.
OLFACTORY BULB. The bulblike expansion of the olfactory nerve on the under surface of each anterior lobe of the cerebrum (main portion of brain).

PAROXYMAL. Sudden intensification of symptoms.
PERIPHERAL. Pertaining to or situated at or near the surface.
PREMONITORY. Serving as a warning.
PSYCHIC. Pertaining to the mind.
PSYCHONEUROTIC. Having a disordered mind; hysterical.
PUNCTIFORM. Like a point; located in a point.
PURULENT. Consisting of or containing pus.
PYORRHEA. Discharge of pus.

QUINCKE'S EDEMA. Acute circumscribed edema of the skin.

SALIVATION. Excessive discharge of saliva.
SATURNISM. Lead poisoning.
SEBACEOUS. Secreting a greasy lubricating substance.
SPASMODIC. Of the nature of a spasm.
STOMATITIS. Inflammation of the mouth.

UREMIA. The presence of urinary constituents in the blood, and the toxic condition produced thereby.

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